NRI research highlights

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Developing Oils Through Genetic Engineering

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Seed oils are important sources of industrial chemicals and of energy for food and fuel. Fatty acids, the building blocks of seed oils, serve as critical feedstocks for soaps, detergents, diesel fuels, lubricants, plastics, and many other industrial products.

Found in great variety in nature, fatty acids impart unique chemical, physical, and nutritional properties to seed oils. Of the approximately 300 fatty acids found in nature, fewer than 10 currently are produced on a significant commercial scale. This is due primarily to two factors: (1) the dominance of nonrenewable feedstocks (e.g., petrochemicals) in the industrial marketplace, and (2) the fact that most of the naturally occurring fatty acids are produced by wild plant species with limited promise as crops. The chemical diversity produced by these species, however, can be exploited by transferring genes from wild plants to crops through genetic engineering.

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THE FLOWER OF *CUPHEA LANCEOLATA*. *CUPHEA* SEEDS ARE THE RICHEST KNOWN SOURCES OF MEDIUM-CHAIN FATTY ACIDS.

Genetic Mechanisms

The National Research Initiative (NRI) Competitive Grants Program is supporting research at Oregon State University focused on genetic mechanisms underlying the synthesis of medium-chain fatty acids (MCFAs) in the plant genus *Cuphea* (see illustration). This group of 260 wild plant species is the richest known source of MCFAs.

The long-range goal of the project is to understand the mechanisms by which *Cuphea* produces pure, medium-chain oils, so that crop plants can be genetically engineered to produce these oils as well. Creation of domestic sources of medium-chain oils could mean a decrease in U.S. dependence on imported tropical oils as sources of MCFAs for the manufacture of soaps, detergents, and other products.

Plant Engineering

The research at Oregon State entails the cloning and engineering of genes of two gene families — thioesterases and syn-

The importance of seed oils as sources of industrial chemicals and fuels is expected to increase in future decades.

thases — from *Cuphea wrightii* and the introduction of these genes into *Arabidopsis*, a plant commonly used as a model organism for crop plant engineering.

Initial studies demonstrated that although *Arabidopsis* plants engineered with thioesterase genes from *Cuphea wrightii* produced MCFAs, these genes alone did not reproduce the fatty acid composition of oils produced by *Cuphea wrightii*. Suspecting that synthase genes might be necessary to accomplish this, the researchers next cloned synthase genes from *Cuphea wrightii*.

Arabidopsis plants engineered with cloned synthase genes produced fewer of the saturated long-chain fatty acids (such as palmitic acid) produced by untransformed *Arabidopsis* plants, but did not produce MCFAs. This result showed that palmitic acid content can be lowered in crop plants by introducing *Cuphea* synthase genes, but that synthase genes are not sufficient to produce MCFAs in the long-chain oil crops — such as soybeans and sunflowers — that the researchers wish to transform and grow commercially to produce MCFAs.

An important finding centered on the fact that when *Cuphea* thioesterase and synthase genes were introduced simultaneously into the *Arabidopsis* plants, the plants engineered with both genes produced MCFAs in proportions similar to those produced by *Cuphea wrightii*. In plants engineered with thioesterase, the synthase genes shifted the synthesis of fatty acids toward shorter chains.

IMPACT

This research demonstrates that novel synthases and thioesterases are both necessary and sufficient to reproduce the fatty acid composition found in *Cuphea*. It also shows that synthase genes can be used to alter fatty acid composition in crop plants.

Discoveries resulting from the study could benefit U.S. agriculture by facilitating creation of foods and medicines as well as supplies of novel industrial chemicals for soaps, detergents, diesel fuels, lubricants, and plastics. An important application also is expected in future decades as petrochemical supplies dwindle, prices rise, and the importance of seed oils as sources of industrial chemicals and fuels increases. Crop plants engineered with *Cuphea* could play a major role in supplying replacements for these raw materials. ❖

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